



Application Research of BIM and VR Technology in Interactive Design of Construction Industry

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Abstract: Both BIM and VR have their own characteristics, and the combination of them can not only create fine architectural models, but also achieve immersive VR interactive experiences. This paper takes a teaching building of a university as an example, creates a BIM model, and designs indoor and outdoor scenes for the model. Combined with VR technology, multi-department and cross-professional collaborative design can be realized in the design stage, assisted construction of immersive virtual environment and personnel safety training can be realized in the construction stage, and interactive design based on data information can be implemented in the operation and maintenance stage. Carry out cloud visits and emergency response exercises in emergencies such as fires and earthquakes.

Keywords: BIM; VR; interactive design; construction industry.

1 BIM and VR technology

1.1 BIM Technology and its Development

BIM is the acronym of "Building Information Modeling". It is an engineering data model that integrates various related information of construction projects based on three-dimensional digital technology. BIM is the digital expression of the entity and functional characteristics of the engineering project facilities. BIM technology is a digital expression to describe the geometric information, physical information and functional information of the building, so as to provide corresponding technical support for the design, construction, operation, maintenance and management of the building. Therefore, BIM technology is based on three-dimensional technology, the core is information data, and the goal is to clearly describe the logical relationship of the whole process of the project. BIM technology has changed the production mode of the traditional construction industry. Through BIM model, information can be shared among various professionals involved in the project to ensure the transmission of information in the whole life cycle of the building. It is conducive to the fine management of the project, which can reduce the project cost and improve the quality and efficiency of the project.

At present, the research and application of BIM in the domestic construction industry is gradually deepening, such as the specific application in Beijing Bird's Nest, Shanghai Center, China Zung, Tianjin 117 Building and other practical projects. Moreover, in recent years, BIM technology has been promoted through government guidance and enterprise implementation. For example, on October 14, 2010, the Ministry of Construction issued a notice of application promotion specifically for "10 new technologies in Construction Industry", in which it was proposed to promote the use of BIM technology to assist construction management. In 2011, the Ministry of Science and Technology took BIM system as a key research project "Research and Application of key technology of Informatization in Construction Industry" in the "Twelfth Five-Year Plan". On August 23, 2016, the Ministry of Housing and Urban-Rural Development issued the "2016-2020 Informatization Development Outline for the Construction Industry", which clearly proposed to "accelerate the popularization and application of BIM, realize the upgrade of survey and design technology", and listed BIM technology as the first of the five information technologies. Efforts will be made to enhance the application of BIM, big data, intelligence, mobile communication, cloud computing, Internet of Things and other information technologies in the construction industry, and comprehensively improve the informatization level of the construction industry. BIM technology has entered a rapid development stage in our country.

1.2 VR Technology, and its Development

VR, the full name of Virtual Reality, is a computer-generated, interactive three-dimensional dynamic effect. Immersive virtual reality is the use of computers to generate three-dimensional virtual environment, experiencers through a variety of hardware devices (3D glasses, head-mounted display, ring projection equipment, motion sensing handle, etc.) into the environment, and can interact with the environment. In this environment, the experiencer can observe the objects in the environment through natural skills (such as the movement of the limbs, the rotation of the eyes), and can get multi-sensory and natural perception, with immersive effects.

Due to the short start time of VR technology, VR technology is first applied to military, medical and other fields, the application of civilian field was initially based on games, and entered the construction industry in recent years, and the industry generally believes that 2016 is the first year of VR technology. According to the current research status at home and abroad, the application of VR technology in the industry mainly has four aspects: auxiliary architectural design, cultural heritage protection, urban and rural planning and design, and auxiliary architectural education^[1].

At present, there are abundant research results on BIM technology both at home and abroad in terms of theoretical exploration, engineering practice and software innovation. According to the research results, BIM technology has been fully applied to the whole life cycle of buildings, but it has not been able to verify users' feelings on space. At home and abroad, the research on the application of VR technology to the construction industry is still in its infancy. In engineering practice, it mostly exists as a new display medium, and the potential of VR technology has not been deeply ex-

plored. BIM technology has four characteristics: visual operation, complete information, interoperable information and associated information, while VR technology has three characteristics: immersion, interaction and imagination. At present, BIM and VR technologies in the industry are mostly relatively independent applications, and there are few researches on the combination of BIM and VR technologies.

2 Interactive Design Application and Software Based on BIM+VR Technology

The interactive design combined with BIM and VR technology can be applied in the design stage, construction stage and operation and maintenance stage of the whole life cycle of the project (see Fig. 1).

According to the current market application prospects and the richness of supporting software and other influencing factors, Autodesk Revit is selected as the main core modeling software, combined with Autodesk Navisworks for collision inspection and construction simulation, and Fuzor is selected for VR scene construction software. It is a standalone VR software developed specifically for Revit. The following takes a teaching building of a university as an example to introduce the auxiliary construction of immersive virtual environment based on BIM and VR technology in detail.

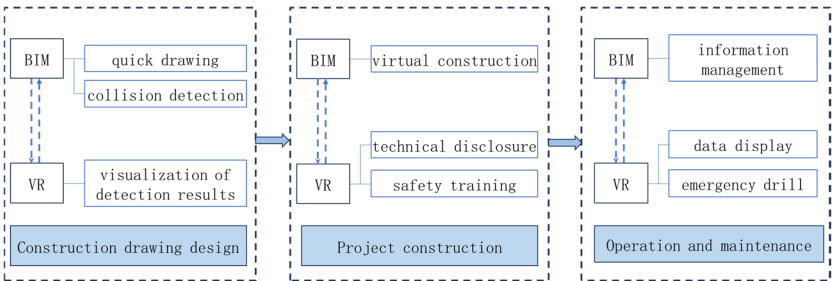


Fig. 1. Application of BIM+VR technology in various stages of the project

3 Application of BIM+VR Technology in Architectural Design

BIM+VR technology is mainly involved in the scheme design from four aspects: site design, general layout, architectural form design, and interior space design.

3.1 Site Design

After the site model is generated by BIM technology and the VR scene is built by VR technology, the architect can have an intuitive feeling of the general situation of the

site, such as terrain, natural landscape, human features, etc., and truly realize the design inside the site.

3.2 General Layout Design

Based on the analysis data in the site design, BIM technology is further used for sunshine analysis, solar radiation analysis and ventilation analysis, and the optimal building spacing and building orientation are selected^[2]. Using VR technology, the shadow occlusion between buildings can be visually displayed. In addition to meeting the requirements of sunlight and ventilation, the spacing should also consider the psychological feelings of people, too much spacing will cause a sense of emptiness, and too small spacing will cause a sense of depression and line of sight interference, because the psychological feelings can not be quantified, can not be described by specific values, so you can reasonably judge the distance between buildings through personal experience in the VR scene.

3.3 Architectural form Design

Designers can use the parameterized design and visual design of BIM technology to observe the three-dimensional model from any Angle, no matter the local details or the whole, control the overall effect, and choose the optimal body design(see Fig. 2). The application of VR technology can more intuitively show the rationality of the building shape in the surrounding environment of the project, such as whether there is a sense of pressure on the surrounding buildings.



Fig. 2. BIM 3D model

3.4 Building Interior Space Design

BIM technology is used to comprehensively analyze the sound, light, heat, wind and other aspects of the interior space of the building, improve the comfort level of the

interior space of the building, verify the actual performance after completion in advance, and take corresponding measures to optimize and adjust the design scheme. The application of VR technology is mainly space perception, streamline analysis, light and shadow analysis and line of sight analysis.

4 Application of BIM+VR Technology in Building Construction

Based on BIM model, all majors (architecture, structure, mechanical and electrical, HVAC) proofread each other, carry out comprehensive and conflict inspection of MEP pipeline(as shown in Fig. 3), detect problems in advance, effectively avoid re-work in the construction process, save materials and time, with the help of VR technology, the test results can be more intuitive and improve the visualization of BIM technology^[3]. Enable all project participants to clearly see the problem. After the construction layout is completed by using BIM technology, the construction node information is integrated to make the model have the time information of the construction schedule, so as to simulate the construction process(see Fig. 4). Before construction, each construction process of each process is visually presented through virtual disclosure, especially the display of some complex nodes, which is more conducive to the smooth progress of subsequent construction. The combination of VR technology can also conduct safety training for construction workers, and experience the consequences of dangers in the construction site through visual, auditory, tactile and other multi-perception methods in the VR scene, which is conducive to improving the safety awareness of construction workers and avoiding accidents^[4].

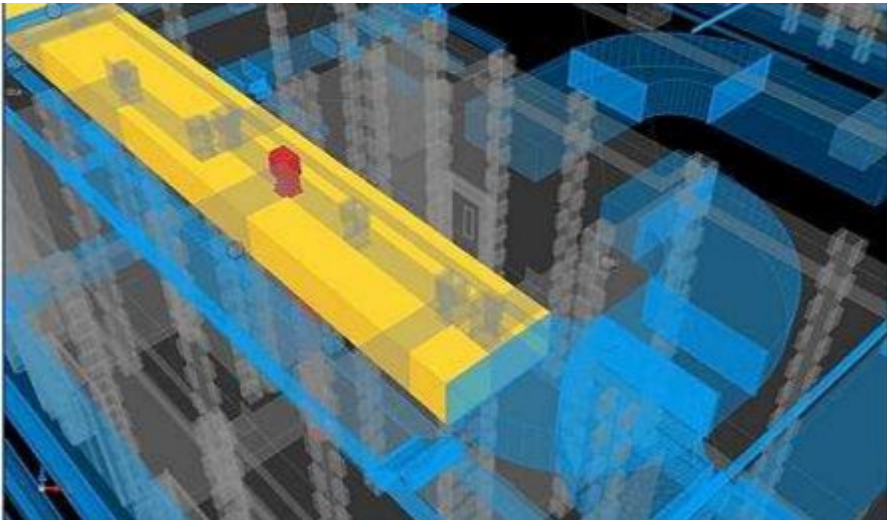


Fig. 3. Collision detection

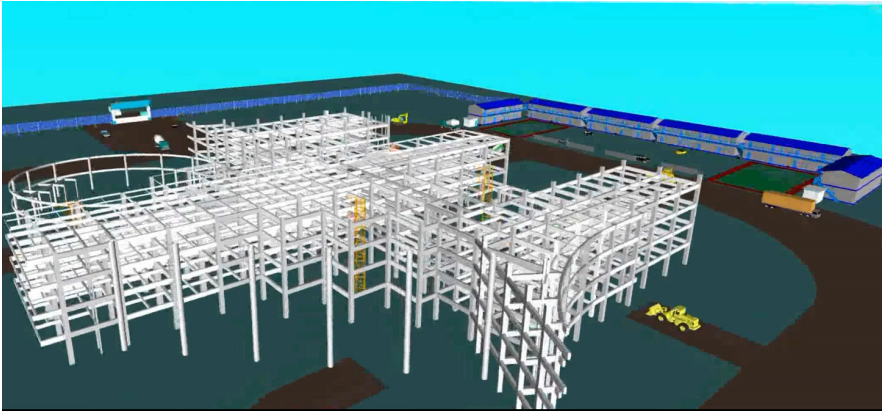


Fig. 4. Virtual construction

5 Application of BIM+VR Technology in the Decoration Stage

Through the external decoration material database, decoration style database, etc., it greatly facilitates the selection and design of decoration designers. The two technologies can also show the effect of the design in an interactive form, and the decoration designer can also roam in this space, so that we can achieve the decoration effect we need to see in the next few months in a very short time. After the end of the design scheme, the user can feel the interior hardcover in advance, on the premise of customer satisfaction, to ensure that the decoration meets customer requirements. As shown in Fig. 5, it is the decoration drawing of the computer room.



Fig. 5. Computer room decoration drawing

6 Application of BIM+VR Technology in Operation and Maintenance Stage

6.1 Teaching Building Cloud Visit

VR technology can generate panoramic photos and videos of the teaching building and upload them to the network. Users only need to have a pair of simple VR glasses to visit the teaching building anytime and anywhere and experience the internal space. Compared with the traditional way of viewing renderings or roaming animations, VR technology presents the result to people in three-dimensional, which is a new way of experience. This method can not only be used in the early school enrollment publicity, but also can be used in the entrance education of new students.

6.2 Interactive Design of Fire Emergency Evacuation

The teaching building is one of the areas where university personnel gather. In order to solve the problem of personnel evacuation in the case of fire and reduce casualties and property losses, the multi-objective plan with the shortest planning time and optimal path is made by comprehensively considering the evacuation scenario, the attributes of evacuees and the source of fire, etc., which provides a scientific basis for the interaction study of cafeteria personnel evacuation path^[5]. Based on the analysis of the fire escape route, it is applied to the interaction of virtual reality design platform to make the interactive design of indoor emergency escape route. According to the evacuation interaction design, teachers and students can really feel the danger coming when there is no fire, and make psychological preparation in advance. In the event of a fire, you can take it easy.

In the operation phase, VR can be used to complete the teaching building roaming, fire or earthquake emergency evacuation interaction, enabling students to visit the teaching building through VR devices, immersive remote, and experience the fire emergency evacuation interaction and earthquake emergency response exercises in case of emergencies.

7 Conclusion

Both BIM and VR have their own characteristics, and the combination of them can not only create fine architectural models, but also achieve immersive VR interactive experiences. This paper takes a teaching building of a university as an example, creates a BIM model, and designs indoor and outdoor scenes for the model. Combined with VR technology, multi-department and cross-professional collaborative design can be realized in the design stage, assisted construction of immersive virtual environment and personnel safety training can be realized in the construction stage, and interactive design based on data information can be implemented in the operation and maintenance stage. Carry out cloud visits and emergency response exercises in emergencies such as fires and earthquakes.

In the future, BIM+VR technology will make greater progress and open up new application fields. The combination of AR, MR (mixed reality) and BIM technology will also provide more possibilities to create more innovative technological achievements, leading the construction industry to a new era.

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